Elements - elements are pure homogeneous forms of matter

- **Solid**
  - Constant volume & shape
  - Very low compressibility
  - Particles vibrate in place
  - Highly ordered arrangement
  - Does not flow or diffuse
  - Interatomic attractive forces between particles are usually more dense than liquids

- **Liquid**
  - Substantial volume but takes on the shape of container
  - Low compressibility
  - Random particle movement
  - Moderately dense
  - Waists attractive forces are more dense than gaseous

- **Gas**
  - Variable volume and shape
  - High compressibility
  - Random particle movement
  - Extreme disorder
  - Flow and diffuse easily
  - Weakest attractive forces
  - Least dense state
  - Exert a pressure easily

- **Plasmal**
  - Like a gas except it is composed of ions, not all is charged
  - Can be ions or charged group of atoms
  - Examples:
    - Flames
    - Atmosphere of star
    - A comet's tail

**Isotopes**

- All atoms of the same element are not exactly alike
- Mass number equals the sum of protons + neutrons in the nucleus.
- Atomic number

- Isotopic Symbolism

<table>
<thead>
<tr>
<th>Mass number</th>
<th>Atomic number</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>57</td>
<td>26</td>
<td>Fe 57</td>
</tr>
</tbody>
</table>

A. Know how to draw correct isotopic symbols.
B. Know how to interpret the meaning of each symbolic part.
C. All isotopes (isotopic symbols) are given a mass number.

Learn to interpret isotopic symbolism.

- Mass number = protons plus neutrons
- Atomic number 26 = Fe
- 26 protons = 26 electrons for atoms
- How many protons and neutrons are in the nucleus of iron-57?
- Mass number minus atomic number equals number of neutrons
- (57 - 26) = 31 neutrons
Elements are made from atoms having the same atomic number, protons
Are all atoms of one particular atom the same or are they mixtures?
1) All atom nuclei for an element have the same number of protons.
2) Every atom in an element has the same number of protons & electrons
3) However, elements are mixtures of their isotopes
4) Isotopes are same atom but can have a different mass number
5) Mass number equals the total number of protons and neutrons in
the nucleus for an atom.
6) Mixtures of isotopes for a given element can be physically separated
by use of a mass spectrometer

Learn to interpret the below isotopic symbolism.

Isotopes
Is a mass number attached
All atoms of the same element
The element is a mixture
of its isotopes and has an
average mass as determined by a
mass spectrometer.

atomic number
FES
also can be written as iron-57
atomic number 26 = Fe
26 protons = 26 electrons
mass number 57

All atoms of the same element are not exactly alike

31 neutrons

How many protons and neutrons are in the nucleus of iron-57?

mass number minus atomic number equals number of neutrons

(57 - 26) = 31 neutrons

HO 34

Isotopes of Hydrogen & Nuclear Fusion
Dr. Gerenz - Mesa College

 KNOW for each subatomic particle:
• its mass
• its properties
• its location about the atom

Let’s break it down:
• calculating the number of neutrons, protons and electrons
• drawing isotopic symbols
For the illustration, calculate the number of neutrons, protons & electrons using the legend above.

Atoms have equal numbers:
- \( n = 0 \) (physical identity)
- \( p = 1 \) (physical identity)
- \( e = 1 \) (chemical reactivity)

\[ ^1 \text{H} \]

\[ ^2 \text{H} \]
Draw Isotopic Symbolism

3
H

1
atomic number on bottom

mass number on top

n = two
p = one (physical identity)
e = one (chemical reactivity)

Calculate the number of neutrons, protons & electrons

Average Atomic Mass

atomic mass is an average mass of naturally occurring isotopes

99% (1amu) + 1%(2amu) = 1.01 amu

Average Atomic Mass for H
The separation of the isotopes of chlorine as seen in the movie “medicine man”

In the movie the separation of chlorine isotopes were accomplished by the use of a mass spectrometer

Got’s to save that rain forest
Go Sean go!!!

The Mass Spectrometer

The element chlorine is a mixture of two isotopes in a 3 to 1 ratio which gives a mass spectrum that is a finger print for the isotopes of chlorine-35 & chlorine-37

Average Atomic Mass \[ 75\% \times 35\text{amu} + 25\% \times 37\text{amu} = 35.5\text{amu Cl} \]
Average Atomic Mass

atomic mass is an average mass of naturally occurring isotopes

Draw Isotopic Symbolisms for chlorine-35 & chlorine-37

Mass number equals neutrons plus protons

\[ ^{35}\text{Cl} \quad ^{37}\text{Cl} \]

\[ n = 18 \quad p = 17 \quad e = 17 \]

\[ n = 20 \quad p = 17 \quad e = 17 \]

Natural terrestrial abundance of chlorine-35 & chlorine-37 is 75% and 25%, respectively

Average Atomic Mass

\[ 75\% \times 35\text{amu} + 25\% \times 37\text{amu} = 75\text{.}5\text{ amu Cl} \]
So elements can be physically separated by a mass spectrometer, but can atoms in elements be chemically changed or altered?

Yes, elements can be chemically changed in a **nuclear reaction**, either by

1) **fission** (a large atom fizzes down into smaller atoms)
2) **fusion** (to fuse atoms together into large atoms)

Hmm…what could I do with this?

The Atomic Age: From fission to fallout

http://www.cnn.com/SPECIALS/cold.war/experience/the.bomb/history.science/
Nuclear fission at its best

or Worst

2011 tsunami, following a 9.0 magnitude quake, triggered the world's worst nuclear disaster in a generation

http://history.sandiego.edu/gen/filmnotes/chinasyndrome.html

Nuclear Chemistry at its best???

Cold Fusion???? (pure fantasy)

The science of producing the power of the sun at room temperature is pure fantasy....

...however women pursuing careers in science is not fantasy
The Nobel Prize in Chemistry

Marie Curie - Facts

Marie Curie, née Sklodowska

Born: 7 November 1867, Warsaw, Russian Empire (now Poland)

Died: 4 July 1934, Sallanches, France

Affiliation at the time of the award: Sorbonne University, Paris, France

Prize motivation: "In recognition of her services to the advancement of chemistry by the discovery of the elements radium and polonium, by the isolation of radium and the study of the nature and compounds of this remarkable element"

Field: nuclear chemistry

The Nobel Prize in Chemistry

The Nobel Prize in Chemistry 2009

* Ada E. Yonath

"For studies of the structure and function of the ribosome"

The Nobel Prize in Chemistry 1964

* Dorothy Crowfoot Hodgkin

"For her determinations by X-ray techniques of the structures of important biochemical substances"

The Nobel Prize in Chemistry 1935

* Irène Joliot-Curie

"In recognition of their synthesis of new radioactive elements"

The Nobel Prize in Chemistry 1911

* Marie Curie, née Sklodowska

"In recognition of her services to the advancement of chemistry by the discovery of the elements radium and polonium, by the isolation of radium and the study of the nature and compounds of this remarkable element"

Ada E. Yonath - Facts

Ada E. Yonath

Born: 30 June 1934, Jerusalem, British Mandate of Palestine (now Israel)

Affiliation at the time of the award: Weizmann Institute of Science, Rehovot, Israel

Prize motivation: "For studies of the structure and function of the ribosome"

Field: Biochemistry, structural biology

Dorothy Crowfoot Hodgkin - Facts

Dorothy Crowfoot Hodgkin

Born: 17 May 1909, Cark, Egypt

 Died: 23 July 1994, St John's, Oxford, United Kingdom

Affiliation at the time of the award: University of Oxford, Royal Society, Oxford, United Kingdom

Prize motivation: "For her determination by X-ray techniques of the structures of important biochemical substances"

Field: Biochemistry, structural biology

The Nobel Prize in Chemistry 1935

* Dorothy Crowfoot Hodgkin

"For her determination by X-ray techniques of the structures of important biochemical substances"

Field: Biochemistry, structural biology

The Nobel Prize in Chemistry 1909 was awarded jointly to Frédéric Joliot and Irène Joliot-Curie in recognition of their synthesis of new radioactive elements and compounds.
Nuclear Chemistry at its best

HOT Fusion

The science of producing the power of the sun in San Diego is a reality

The Tokamak Reactor at General Atomics

http://fusion.gat.com/

Nuclear fission in San Diego will begin with three isotopes of hydrogen.

Isotopes of Hydrogen & Nuclear Fusion
Dr. Gerardo - Mesa College

- neutron (n) mass ≈ 1 amu (atomic mass unit)
- proton (p) mass = 1 amu
- electron (e) mass = 1/2000 amu

hydrogen, H

- most stable form
- most abundant
- 99% naturally occurring

deuterium, D

- hydrogen-2
- stable form
- but twice as heavy as H
- 1% naturally occurring

tritium, T

- hydrogen-3
- least stable form
- radioactive
- synthetically made
Radiation - Know the three types of radiation and their characteristics

<table>
<thead>
<tr>
<th>Name and Symbol</th>
<th>Identity</th>
<th>Charge</th>
<th>Mass (amu)</th>
<th>Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha (α)</td>
<td>Helium nucleus</td>
<td>2+</td>
<td>4</td>
<td>Low</td>
</tr>
<tr>
<td>Beta (β)</td>
<td>Electron</td>
<td>1-</td>
<td>1/1820</td>
<td>Medium</td>
</tr>
<tr>
<td>Gamma (γ)</td>
<td>Radiant energy</td>
<td>0</td>
<td>0</td>
<td>High</td>
</tr>
</tbody>
</table>
Radiation - Know the characteristics of radioactive isotopes

Characteristics of Radioactive Isotopes

- Binding energy - the energy that holds the protons, neutrons, and other particles together in the nucleus.
- List the four factors responsible for nuclear stability:
  1. Nuclear stability correlates with the ratio of neutrons to protons in the isotope. A ratio of 1:1 is preferred.
  2. Nuclei with large numbers of protons (Z ≥ 84 or greater) tend to be unstable.
  3. Isotopes containing the "magic numbers" 2, 8, 20, 50, 82 or 126 protons or neutrons are stable.
  4. Isotopes with even numbers of protons or neutrons are generally more stable than those with odd numbers.

Nuclear Reaction - Know the process for balancing nuclear reactions

A. In each of the above reactions, the reaction arrow means “goes to”
B. The reactants are on the left, and the products are on the right
C. Total mass (mass numbers) of reactants must be equal to the total mass (mass numbers) of the products

210
84 Po → 4 α + 206
21 Pb

222
86 Rn → 4 α + 218
84 Po

40
20 Ca → 0 β + 40
21 Sc

238
92 U → 0 β + 238
93 Np

235
92 U → 4 α + 231
90 Th

247
97 Bk → 4 α + 243
95 Am

D. Total protons (atomic numbers) of reactants must be equal to the total protons (atomic numbers) of the products

reactant(s) → product(s)